

Stated Meeting, December 18th, 1863.

Present, fourteen members.

Dr. WOOD, President, in the Chair.

Letters acknowledging publications were received from the British Museum, November 26, and the Society of Antiquaries, London, November 20th, 1863.

A letter from the Secretary of the Smithsonian Institution, December 12th, was received, asking for the loan of ethnological specimens in the cabinet, for the purpose of having plaster casts of them made for the cabinet of the Institution. On motion, this communication was referred to the Curators, with power to grant the request.

A letter from Prof. Zantedeschi, dated Padua, November 20, was received, together with a copy of an extract from the proceedings of the Institute of Science of Venice, containing an inedited letter of Carlini. The communication was, on motion, referred to the Secretaries.

*Alla Celebre Societa' Filosofica Americana in Filadelfia.**Della Fotografia dei prototipi del mondo esteriore.*

Nell' adunanza del 24 Novembre, 1862, io aveva l'onore di comunicare all' I. R. Istituto Veneto una lettera inedita direttami dall' astronomo e geometra Francesco Carlini intorno ad un piano di di meteorologia ed all' applicazione della camera lucida al cannocchiale per ottenere dei panorami di monti in grande scala e della maggiore esattezza, e poneva fine alla mia comunicazione con queste precise parole: "I fotografi amora troveranno utilissima l'applicazione della camera lucida al cannocchiale pei panorami delle vedute lontane, con tutte quelle degradazioni della prospettiva aerea, che solo la natura geometricamente sa dare. Alla carta comune de' disegni non hanno che a sostituire la carta sensibilizzata."

A proporre questa applicazione io sono stato condotto dal principio filosofico: l'immagine obbiettiva non e' che l'immagine subbiettiva riflessa, rifersta dallo spirito all' oggetto, dal quale si deriva l'eccittamento delle irradiazioni. E percio' fotografando l'immagine subbiettiva, si fotografa l'immagine subbiettiva, o della retina. Applicato l' occhio alla camera lucida, esso invia dal suo fondo i razzi chimici sul piano della carta fotografica, che vi producono un' impressone,

ad una immagine, la quale altro non a' che quella della retina direttamente fotografata. Il dubbio, che potrebbe insorgere contro di questa applicazione, devesi ripetere dalla possibilita' di fotografare un' immagine esistente sulla retina dell' occhio. È noto ai fisiologi, che l'impressione del raggio sulla retina dell' occhio non è istantanea, ma persistente per qualite frazione di minuto secondo. Rimaneva a ricercarsi, se questa persistenza fosse duratura anche dopo la morte dell' uomo. Dalle dottrine fisiologiche si poteva argomentare affermativamente; perchè, estinta la vita sensitiva, le forze chimiche riescono prevalenti alle fisiologiche. Ma è merito del Sigr. Dottor Sandford di Boston di avere per il primo fotografata l'immagine persistente nella retina di un uomo di fresco ucciso. Ecco come viene narrata dai Giornali questa maravigliosa scoperta. Si trattava di procurarsi l'immagine di un assassino rimasto sconosciuto, facendo, il piu' presto possibile dopo il delitto, la fotografia degli' occhi della vittima. Venne ucciso un certo Beardsley da ignoto assassino. H. Dr. Sandford con una leggera soluzione di atropa belladonna, sriluppo' la pupilla e tosto fere fotografare l'occhio ed appresso con un microscopio esaminò la carta fotografata e vi discopri la figura e le vesti dell' uccisore. Quantunque impertanto sul piano della carta fotografica non giunga, a mezzo della camera lucida di Wollaston applicata al cannocchiale, alcun raggio proveniente direttamente dall' oculare del cannocchiale, vi giungono tuttavia quelli dell' immagine persistente sulla retina dell' occhio. Dopo cio' sembra potersi fotografare anche colla semplice camera lucida non applicata al cannocchiale; perchè si fotografa sempre l'immagine impressa sulla retina, nell' atto che si riferisce sulla carta preparata l'immagine di una vedata; come evidentemente è dimostrato dalla posizione dell' immagine detta obbiettiva, che è sempre rivolta all'occhio, o alla immagine subbiettiva della retina, originale tipo del mondo esteriore.

L'argomento mi sembra della piu' alta importanza pei filosofi, fisiologi e fotografi; e perciò non dubito punto, ch'esso richiamerà l'attenzione della nostra Società'.

Sono co' sensi di altissima stima e profondo rispetto.

PADOVA, il 20 di Novembre, 1863.

Donations for the library were received from Prof. Morlot, of Lausanne, the Royal Astronomical Society, the British Meteorological Society, and the Society of Arts, in London, Blanchard & Lea, and the Colonization Herald.

Mr. Chase made some remarks on the diurnal variations of the barometer :

The existence of daily barometric tides has been known for more than a hundred and fifty years ; but their cause is still a matter of dispute. The principal theories that have been brought forward for their explanation attribute them to—

1. Variations of temperature.
2. Variations of moisture.
3. Formation and dissipation of clouds.
4. Electrical action of the sun.
5. Gravitation.
6. Centrifugal force.
7. "Rotation of the earth and its connection with the solar system." [*W. C. Redfield*, in *Silliman's Journal*, vol. 25, p. 129.]

No one has attempted to point out any minute or precise correspondence between theory and observation, nor to furnish any satisfactory demonstration of the connection between the observed phenomena and their supposed causes.

The prevailing sentiment of the day appears to incline towards the temperature-theory, notwithstanding the confessedly inexplicable difficulties that attend it. James Hudson (*London Phil. Trans.*, 1832) points out "the general relation between the barometrical changes and the variations of temperature ;" but he admits that the relation "appears to be DIRECT during the morning hours, and INVERSE during those of the day and evening." Sir John Herschel says that "heat causes diurnal variations ; but the effects surpass the natural operation of those causes." Prof. Espy (4th Meteorol. Report, p. 12) attempts to reconcile the American observations with his view of the heat-theory. His explanations, though plausible, are unsatisfactory, and will not bear the test of rigid scrutiny. It seems evident, therefore, that the variations of the barometer cannot be accounted for by variations of temperature ; for, 1st, their regularity is not perceived until all the *known* effects of temperature have been eliminated ; 2d, they occur in all climates and at all seasons ; 3d, opposite effects are produced at different times, under the same average temperature. Thus, at St. Helena, the mean of three years' hourly observations gives the following average barometric heights :

From 12h. to 0h. 28·2801 in.	From 6h. to 18h. 28·2838 in.
From 0h. to 12h. 28·2861 in.	From 18h. to 6h. 28 2784 in.

The upper lines evidently embrace the warmest parts of the day, and the lower lines the coolest. Dividing the day from noon to midnight, the barometer is highest when the thermometer is highest; but in the second division the high barometer prevails during the coolest half of the day.

Each of the other enumerated causes undoubtedly exerts an influence which must be carefully investigated before we can obtain a thorough knowledge of the laws which control the atmosphere. Such an investigation will probably show a mutual connection, through which all the secondary causes may be referred to a single force. Mr. Redfield's hypothesis, which is sufficiently indefinite and general to include all the rest, was anticipated by Galileo, who attributed the ocean tides "to the rotation of the earth, combined with its revolution about the sun." It appears that Galileo's opinion attracted little attention and led to no special investigation, partly, perhaps, because it was difficult to reconcile it with the tidal intervals, and partly because a literal as well as figurative reasoning in a circle apparently demonstrated that the motions in question could produce no disturbing force. I will endeavor to point out the fallacy of this conclusion by deducing, from a reference of the aerial motions to a supposed stationary earth, a law of tidal variation nearly identical with the law that is derived from a consideration of the relative attractions of two bodies revolving about their common centre of gravity.

On account of the combined effects of the earth's rotation and revolution, each particle of air has a velocity in the direction of its orbit, varying at the equator from about 65,000 miles per hour, at noon, to 67,000 miles per hour at midnight. The force of rotation may be readily compared with that of gravity by observing the effects produced by each in twenty-four hours, the interval that elapses between two successive returns of any point to the same relative position with the sun. The force of rotation producing a daily motion of 24,895 miles, and the force of terrestrial gravity a motion of 22,738,900 miles, the ratio of the former to the latter is $\frac{24895}{22738900}$, or .00109. This ratio represents the proportionate elevation or depression of the barometer above or below its mean height, that should be caused by the earth's rotation, and it corresponds very nearly with the actual disturbance at stations near the equator.

From 0h. to 6h. the air has a forward motion greater than that of the earth, so that it tends to fly away; its pressure is therefore diminished, and the mercury falls. From 6h. to 12h. the earth's

motion is greatest; it therefore presses against the lagging air, and the barometer rises. From 12h. to 18h. the earth moves away from the air, and the barometer falls; while from 18h. to 24h. the increasing velocity of the air urges it against the earth, and the barometer rises.

If the force of rotation at each instant be resolved into two components, one in the direction of the radius vector, and the other parallel to the earth's orbit, it will be readily perceived that whenever the latter tends to increase the aerial pressure, the former tends to diminish it, and *vice versa*. Let B = the height of the barometer at any given instant; M = the mean height at the place of observation; $\theta = 90^\circ$ = the hour angle; C = the earth's circumference at the equator; $t = 24$ hours; g = the terrestrial gravity; l = the latitude; and a simple integration gives the theoretical formula,

$$B = M \left(1 + \frac{\sin. \theta. \cos. \theta. \cos. l}{R^3} \cdot \frac{2C}{gt^2} \right).*$$

This formula gives a maximum height at 9h. and 21h., and a minimum at 3h. and 15h. The St. Helena observations place the maximum at 10h. and 22h., and the minimum at 4h. and 16h., an hour later in each instance than the theoretical time. This is the precise amount of retardation caused by the inertia of the mercury, as indicated by the comparisons with the water barometer of the Royal Society of London.

Aerial currents, variations of temperature, moisture, and centrifugal force, solar and lunar attraction, the obliquity of the ecliptic, and various other disturbing causes, produce, as might be naturally expected, great differences between the results of theory and observation. But, by taking the grand mean of a series of observations, sufficiently extended to balance and eliminate the principal opposing inequalities, the two results present a wonderful coincidence.

According to our formula, the differences of altitude at 1, 2, and 3 hours from the mean, should be in the respective ratios of .5 .866, and 1. The actual differences, according to the mean of the St. Helena observations, are as follows :

* $\frac{C}{gt^2}$ represents the effective ratio of an entire day. But there is in each day a half day of acceleration, and a half day of retardation, and the ratio for each half day is $\frac{C}{2} + \frac{gt^2}{4} = \frac{2C}{gt^2}$.

Differences of Barometer.				Ratios.		
Difference of time.	1h.	2h.	3h.	1h.	2h.	3h.
Before 1h. -	·0166	·0298	·0365	·455	·816	1
After 1h. -	·0159	·0266	·0298	·534	·893	1
Before 7h. -	·0122	·0202	·0243	·502	·831	1
After 7h. -	·0135	·0239	·0297	·455	·805	1
Before 13h. -	·0136	·0248	·0284	·479	·873	1
After 13h. -	·0131	·0215	·0227	·577	·947	1
Before 19h. -	·0161	·0287	·0348	·463	·825	1
After 19h. -	·0150	·0265	·0286	·524	·927	1
MEAN, -	·0145	·0252	·0293	·495	·860	1

The mean of the above differences varies from the theoretical mean, less than $\frac{1}{5000}$ of an inch. If we take the mean of the ratios, instead of the ratios of the means of the observed differences, the coincidence is still more striking.

Difference of Time,	1h.	2h.	3h.
Means of observed Ratios,	·498625	·864625	1·000000
Theoretical Means,	·500000	·866025	1·000000

The calculated time for the above observed means, differs less than 20" from the actual time.

Observed Means,	·498625	·864625	1·000000
Theoret. Difference of Time,	59' 48"	119' 40"	180'
Observed Difference of Time,	60' 0"	120' 0"	180'

The varying centrifugal force to which the earth is subjected by the ellipticity of its orbit, must, in like manner, produce annual tides. The disturbing elements render it impossible to determine the average monthly height of the barometer with any degree of accuracy, from any observations that have hitherto been made. We may, however, make an interesting approximation to the annual range, still using the St. Helena records, which are the most complete that have yet been published for any station near the equator. Comparing the mean daily range, as determined by the average of the observations at each hour, with the mean yearly range, as determined by the monthly averages, we obtain the following results :

Year.	Daily Range.	Annual Range.	Ratio.	Approximate Solar Distance.
1844	·0672 in.	·1650 in.	2·4553	137,070,000 m.
1845	·0646 in.	·1214 in.	1·8793	80,300,000 m.
1846	·0670 in.	·1214 in.	1·8120	74,650,000 m.
	3)·1988	3)·4078	3)6·1466	
	·0663	·1359	2·0489	95,446,000 m.
Mean,	·0663	·1290	1·9457	86,056,000 m.
	2)·1326	2)·2649	2)3·9946	
	·0663	·1324	1·9973	90,702,000 m.

The approximate estimates of the solar distance are based on the following hypothesis :

Let e = effective ratio of daily rotation to gravity.

a = arc described by force of rotation in a given time t .

r = radius of relative sphere of attraction, or distance through which a body would fall by gravity, during the disturbance of its equilibrium by rotation.

A = area described by radius vector in time t .

Let e' , a' , r' , A' , represent corresponding elements of the annual revolution. Then,

$$A : A' :: ar : a' r' :: e^2 : e'^2$$

But the forces of rotation and revolution are so connected, that a differs but slightly from a'

$$\therefore \left. \begin{array}{l} e^2 : e'^2 :: r : r' \\ r' = \frac{e'^2 r}{e^2} \end{array} \right\} \text{very nearly.}$$

It may be interesting to observe how nearly r (22,738,900 m.) corresponds with Kirkwood's value of $\frac{D}{2}$ (24,932,000 m.). A more thorough comprehension of all the various effects of gravity and rotation on the atmosphere, would probably lead to modifications of our formulæ that would show a still closer correspondence.

There is a great discrepancy between the determinations of the solar distance that are based on the records of 1844 and 1846; but it is no greater than we might reasonably have anticipated. On the other hand, it could hardly have been expected that any comparisons based on the observations of so short a period as three years, would have furnished so near an approximation to the most recent and most accurate determination of the earth's mean radius vector. In

order to obtain that approximation, it will be seen that I took, 1st, the mean of the ranges and ratios for the three successive years; 2d, the ranges and ratios of the mean results of the three years; 3d, the grand mean of these two primary means. I could think of no other method which would be so likely to destroy the effects of changing seasons and other accidental disturbances.

The following table exhibits the effects of latitude on the aerobaric tides. The differences between the theoretical and observed ranges may be owing partly to the equatorial-polar currents, and partly to insufficient observations :

Station.	Lat.	Mean Height.	Mean Range.	Ratio.	Theoret. Ratio.
Arctic Ocean,	78° 37'	29·739 in.	·012 in.	·000404	·000527
Girard College,	39 58	29·938	·060	·002004	·002046
Washington,	38 53	30·020	·062	·002065	·002079
St. Helena,	15 57	28·282	·066	·002344	·002567
Equator,	0	30·709	·082	·002670	·002670

The theoretical ratios are determined by multiplying the equatorial ratios by $\frac{\cos l}{R}$. The formula, $\rho = \frac{\cos l}{R} \cdot \frac{2c}{gt^2}$, (ρ indicating the ratio of the mean range to the mean height), gives

		Theoretical Ratio.	Observed Ratio.
Latitude,	0°	·002190	·002670
Latitude,	78 37'	·000432	·000404

showing that the ratio is less near the pole and greater near the equator than our theory indicates, a natural consequence of the centrifugal force at the equator and the cold surface currents that produce the trade winds.

The revolution of the sun around the great Central Sun must also cause barometric fluctuations that may possibly be measured by delicate instruments and long and patient observation. The Torricellian column may thus become a valuable auxiliary in verifying or rectifying our estimates of the distances and masses of the principal heavenly bodies.

Dr. Wood, requesting Prof. Cresson to take the Chair, described the peculiarities of the growth of the olive tree in Spain and its method of cultivation, reading from his journal an interesting account of his tour through the olive-planting districts.

